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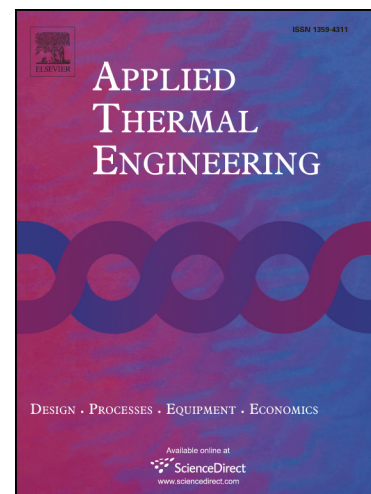
Balancing Stakeholder Priorities in the Operation of Combined Heat and Power Systems

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# Balancing Stakeholder Priorities in the Operation of Combined Heat and Power Systems

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## Abstract

This work explores the impact of re-adjusting demand patterns (electricity and hot water) of building occupants on the economic and environmental performance of combined heat and power (CHP) systems. Trade-off analysis reveals that adjustments in demand patterns provide significant flexibility to synchronize electricity and hot water demands and with this it is possible to minimize water usage, emissions, and cost. As expected, however, such benefits come at expense of significant occupant dissatisfaction. To address this issue, we use a multi-stakeholder optimization framework that takes occupant priorities into account and computes a compromise solution that minimizes the collective stakeholder dissatisfaction. By using this framework, we find that there exist non-obvious CHP operating policies that achieve nearly perfect tracking of nominal occupant demands while significantly improving economic and environmental performance. The proposed framework can be used to inform occupants on the impact of their priorities on CHP performance.

**Keywords:** CHP systems, multi-stakeholder, decision-making, demand patterns.

## 1 Introduction

Combined Heat and Power (CHP) systems are a key technology in decentralized energy systems because they enable higher efficiencies (Gu et al., 2014), reduced environmental impact (Lund, 2007), and superior economic performance (Henning, 1998). In particular, their ability to simultaneously provide multiple energy products (electricity, steam, hot water, chiller water) allows for much higher resource utilization efficiencies. The demand patterns of such energy products, however, are often out-of-phase and have a strong impact on the operational policy of the CHP system (Houwing et al., 2011), on the type of system configuration (Fuentes-Cortés et al., 2015c), on the sizing of the storage units (Fuentes-Cortés et al., 2015a), on the type of fuel used (Fuentes-Cortés et al., 2015b), and on the interaction with utility companies (Basu et al., 2012). Typically, CHP systems are designed and operated under the assumption that energy demands are inflexible (Hafez and Bhattacharya, 2012).

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